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August 8, 2005
File 200553

Mr. Robert Rule
demaximis, inc.
450 Montbrook Lane
Knoxville, TN 37919

Re: Ground Penetrating Radar Survey for Utility Location and Clay Depth
Fields Brook Superfund Site
Ashtabula, Ohio

Dear Mr. Rule:

This letter details the results of a geophysical investigation conducted by Hager GeoScience, Inc. (HGI) for demaximis, inc., (demaximis) in Ashtabula, Ohio in support of DNAPL source identification and delineation at the Fields Brook Superfund Site. The purpose of the survey was to locate buried utilities and to map the depth to an impermeable gray clay layer. The survey was performed using ground penetrating radar (GPR).

SURVEY PROCEDURE

HGI personnel conducted the investigation July 25^{th} to 27^{th}, 2005, in areas designated by demaximis representatives. HGI personnel laid out two separate orthogonal survey grids using spray paint and fiberglass tapes. The grids were referenced to specific locations by measuring from surface cultural features. The surface was predominantly flat and grass covered.

The HGI field crew collected GPR data west of the existing Detrex Corporation buildings, within a site fence limit near the current slurry wall, and northeast of the Millennium operations facility, in an open grassy area near Fields Brook. Data were collected in all accessible portions of the survey areas along traverses in two perpendicular directions spaced 5 to 20 feet apart, depending on the survey objectives. The locations of the GPR traverses are shown on Plates 1 and 2, AutoCAD maps adapted from a base map provided by demaximis.

DATA COLLECTION METHOD

GPR data were collected using a GSSI SIR-3000 radar control unit with 100- and 200-MHz antennas and survey wheel for horizontal distance control. The radar system displays data in real time on the color console for quality control and initial data review and interpretation purposes. Utility survey data were recorded using a 200-MHz antenna set at a time range of 100 nanoseconds (ns), for an estimated signal penetration depth of approximately 10 to13 feet. Clay depth data were collected using the 100-MHz antenna, in mono- and bi-static arrangement, set at a time range of 250 and 500 nanoseconds, respectively, for an estimated penetration depth of approximately 20 to 40 feet.

All GPR data were stored in the flash memory of the GPR system and transferred to a PC for later signal processing using RADAN for Windows NT™ software. A detailed description of the GPR method and its limitations is presented in a separate section at the end of this report.

RESULTS

At demaximis' request, HGI marked some utility locations on the ground in Grids 1 and 2 at the completion of GPR data collection, based on preliminary data interpretation in the field. Subsequent review and analysis of the GPR data for both grids resulted in the final plots shown on Plates 1 and 2.

Plates 3 and 4 are clay depth contour maps for Grids 1 and 2, respectively. Contours in Grid 1 are limited to the area east of the slurry wall because excavation and construction activities related to the slurry wall disrupt the clay horizon. The grids show the clay trend; demaximis provided clay depth reference points from cross sections and geoprobe data, some of which appear to be in conflict.

Note that GPR cannot unambiguously determine the physical properties of reflectors, or that all interpreted reflectors are related (see Limitations Section). Confirmation of results via excavation and/or test pitting is strongly recommended.

Please contact us at (781) 935-8111 if you have any questions or need additional information.

Respectfully yours,
HAGER GEOSCIENCE, INC.

Jutta L. Hager

Jutta Hager, Ph.D.
President

GROUND PENETRATING RADAR

DESCRIPTION OF THE METHOD

The principle of ground penetrating radar (GPR) is the same as that used by police radar, except that GPR transmits electromagnetic energy into the ground. The energy is reflected back to the surface from interfaces between materials with contrasting electrical (dielectric and conductivity) and physical properties. The greater the contrast between two materials in the subsurface, the stronger the reflection observed on the GPR record. The depth of GPR signal penetration depends on the properties of the subsurface materials and the frequency of the antenna used to collect radar data. The lower the antenna frequency, the greater the signal penetration, but the lower the signal resolution.

Data Collection. GPR data are collected using a Geophysical Survey Systems (GSSI) SIR 2, SIR 2000, or SIR 3000 ground penetrating radar system. GPR data are digitally recorded on the internal hard drive, or flash-memory of the system. System controls allow the GPR operator to filter out noise, attributed to both coupling noise, caused by conductive soil conditions, spurious noise caused by local EMF fields and internal system noise. For shallow surveys, we use 400-, 200-, 100- or 1500-megahertz (MHz) antennas. For deeper penetration, we use lower frequency antennas ranging from 200 MHz to 15 MHz, depending on the anticipated depth of the target(s) and the degree of signal penetration. All of these antenna configurations can collect data in continuous mode, Distance mode, or as discrete point measurements using signal-stacking techniques. Since there is a trade-off between signal penetration and resolution, test lines are sometimes collected using different antennas at several frequencies and then the highest frequency antenna that produces the highest quality data is used. In some cases, data are collected with several antenna frequencies.

The horizontal scale of the GPR record shows distance along the survey traverse. In the continuous data collection mode, the horizontal scale on each GPR record is determined by the antenna speed along the surface. When a survey wheel is used, the GPR system records data with a fixed number of traces per unit distance. The GPR record is automatically marked at specified distance intervals along the survey line. The vertical scale of the radar record is determined by the velocity of the transmitted signal in the media under study and the range setting, or recording time wind of the GPR system. The recording time interval, or range, represents the maximum two-way travel time in which data are recorded. The conversion of the transmitted signals two-way travel time to depth is determined by the propagation velocity of the GPR signal, which is site (media) specific. When little or no information is available about the makeup of subsurface materials, we estimate propagation velocities from handbook values and experience at similar sites or by CDP velocity surveys with a bi-static antenna.

Data Processing. After completion of data collection, the GPR data are transferred to a PC for review and processing using RADAN for Windows NT™ software. When appropriate, we prepare 3D models of GPR data, which can be sliced in the X, Y, and Z directions.

The size, shape, and amplitude of GPR reflections are used to interpret GPR data. Objects such as metallic UST's and utilities produce reflections with high amplitude and distinctive hyperbolic shapes. Clay, concrete pipes boulders and other in-situ features may produce radar signatures of similar shape but lower amplitude. The boundaries between saturated and unsaturated materials such as sand and clay, bedrock and overburden generally also produce strong reflections.

LIMITATIONS OF THE METHOD

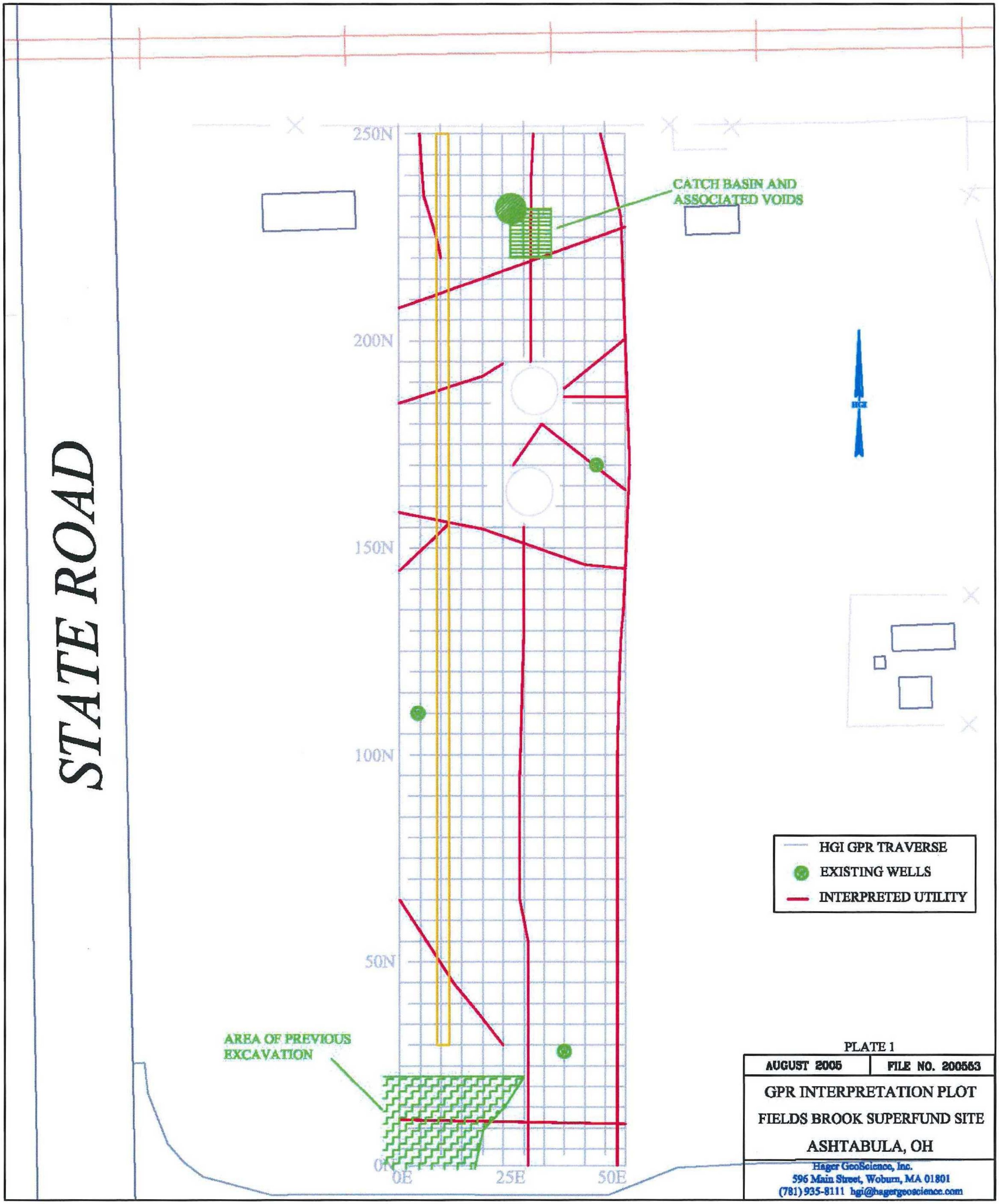
GPR signal penetration is site-specific. It is determined by the dielectric properties of local soil and fill materials. GPR signals propagate well in resistive materials such as sand and gravel; however, soils containing clay, ash- or cinder-laden fill or fill saturated with brackish or otherwise electrically conductive groundwater cause GPR signal attenuation and loss of target resolution. Concrete containing rebar or wire mesh also inhibits signal penetration.

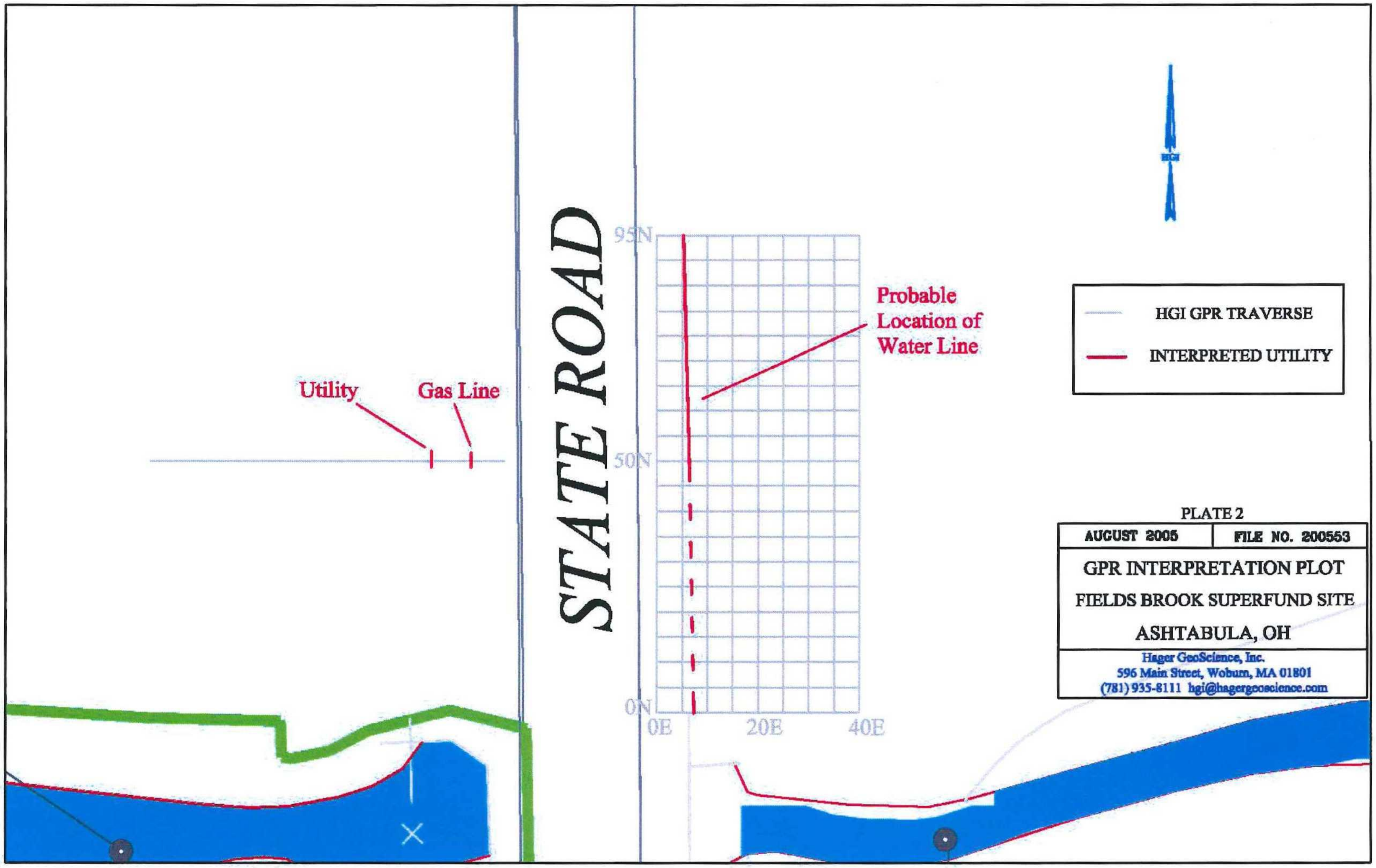
The interpreted depths of objects detected using GPR are based on on-site calibration, handbook values, and/or estimated GPR signal propagation velocities from similar sites. GPR velocities and depth estimates may vary if the medium under investigation or soil water content is not uniform throughout the site.

Utilities are interpreted on the basis of reflections of similar size and depth that exhibit a linear trend; however GPR cannot unambiguously determine that all such reflectors are related. Fiberglass UST's or utilities composed of plastic or clay may be difficult to detect if situated in soils with similar electromagnetic properties, or if situated in fill with other reflecting targets which generate "clutter" or signal scattering and thus obscure deeper reflectors. Objects buried beneath reinforced concrete pads or slabs may also be difficult, but possible, to detect.

Changes in the speed at which the GPR antenna is moved along the surface causes slight variations in the horizontal scale of the recorded traverse. Distance interpolation may be performed to minimize the error in interpreted object positions. The variation in the horizontal scale of the GPR record may be controlled, to a certain extent, with a distance encoder or survey wheel. The GPR antenna produces a cone-shaped signal pattern that emanates approximately 45 degrees from horizontal front and back of the antenna. Therefore, buried objects may be detected before the antenna is located directly over them. GPR anomalies may appear larger than actual target dimensions.

GPR interpretation is more subjective than other geophysical methods. The interpretive method is based on the identification of reflection patterns that do not uniquely identify a subsurface target. Borings, test pits, site utility plans and other ground-truth are recommended to verify the interpreted GPR results.


STATE ROAD
250N
200N
150N
100N
50N
0N
0E
25E
50E
CATCH BASIN AND ASSOCIATED VOIDS
AREA OF PREVIOUS EXCAVATION
HGI
HGI GPR TRAVERSE
EXISTING WELLS
INTERPRETED UTILITY
PLATE 1
AUGUST 2005
FILE NO. 200563
GPR INTERPRETATION PLOT
FIELDS BROOK SUPERFUND SITE
ASHTABULA, OH
Hager GeoScience, Inc.
596 Main Street, Woburn, MA 01801
(781) 935-8111 hgi@hagergeoscience.com



STATE ROAD
95N
50N
0N
0E
20E
40E
Probable Location of Water Line
Utility
Gas Line
HGI GPR TRAVERSE
INTERPRETED UTILITY
HGI
PLATE 2
AUGUST 2005
FILE NO. 200553
GPR INTERPRETATION PLOT
FIELDS BROOK SUPERFUND SITE
ASHTABULA, OH
Hager GeoScience, Inc.
596 Main Street, Woburn, MA 01801
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Depth to Gray Clay Contour Map

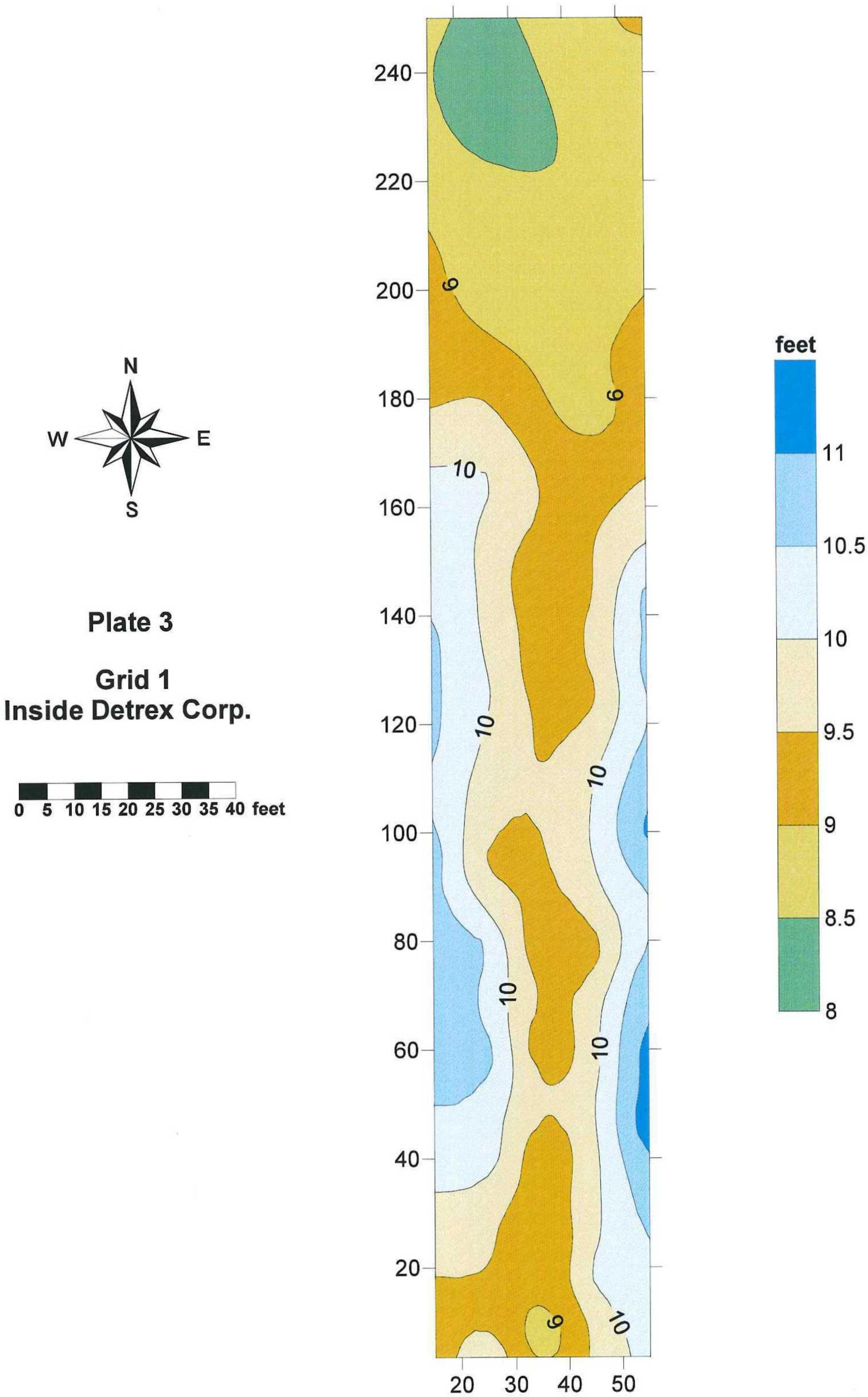
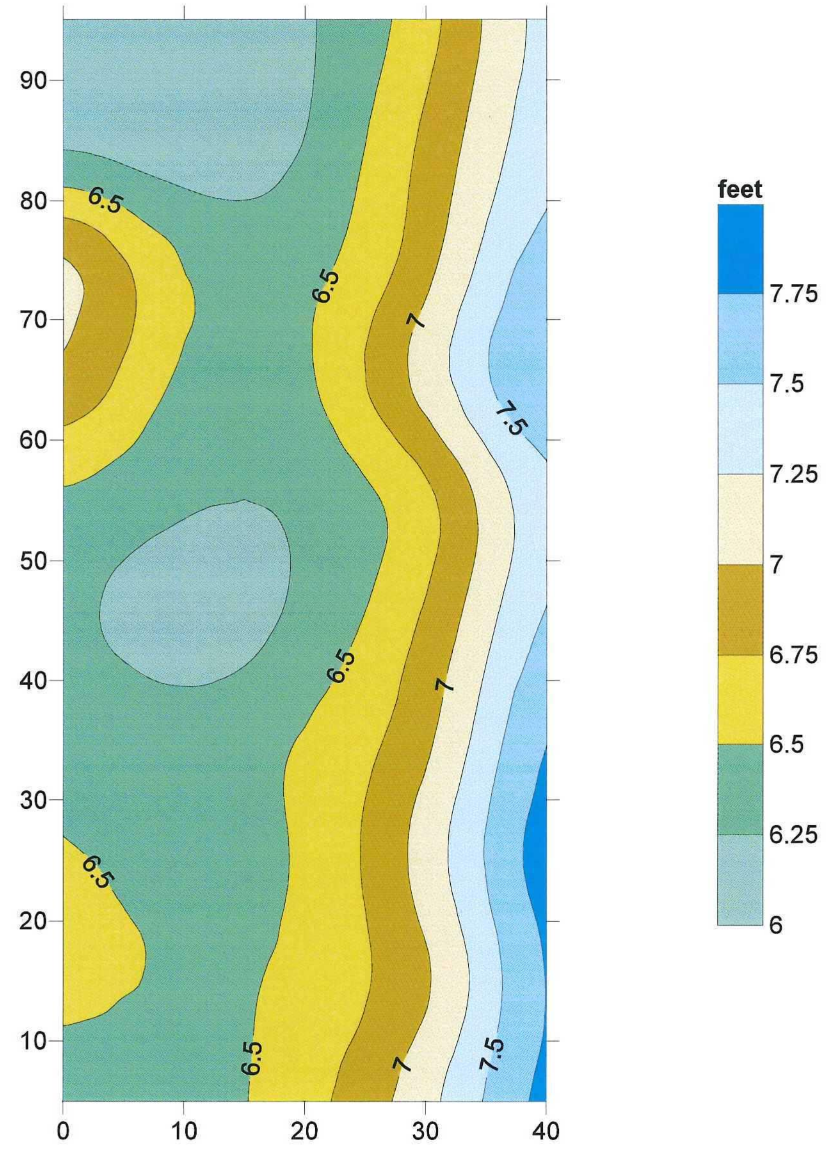


Plate 3

Grid 1
Inside Detrex Corp.

Hager GeoScience, Inc.

Depth to Gray Clay Contour Map



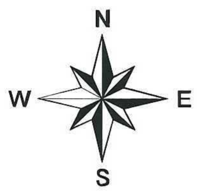
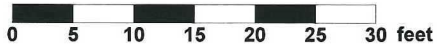


Plate 4

Grid 2
Near Millenium Corp.



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